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Original Article

Orthopaedics Section

Surgical Innovations in Terrible Triad Injuries of the Elbow: A Novel and Innovative FibreWire and Endobutton Method

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ABSTRACT

Introduction: Terrible triad injury, characterised by posterior dislocation of the elbow, radial head fracture, and coronoid fracture, poses significant challenges due to its complex anatomy and the necessity for precise surgical intervention. These injuries are often associated with elbow instability, stiffness, chronic pain, and poor functional outcomes if not managed appropriately. Advances in surgical techniques and fixation methods have improved the prognosis; however, achieving stable joint reconstruction and early mobilisation remains a major challenge for orthopaedic surgeons. Therefore, careful evaluation and timely intervention are essential to restore elbow stability and function.

Aim: This study introduces a novel surgical technique utilising FibreWire and Endobutton in patients with terrible triad injuries of the elbow.

Materials and Methods: This prospective interventional study included 20 patients with terrible triad injuries treated at Department of Orthopaedics, Government Doon Medical College and Hospital, Dehradun, Uttarakhand, India. Surgical management involved anterior capsular augmentation and Lateral Collateral Ligament (LCL) repair using FibreWire, Endobutton, and radial head fixation. Exclusion criteria included patients aged <18 years, severely comminuted radial head fractures, open fractures, polytrauma or associated injuries affecting the treatment protocol or functional outcome assessment, and Medial Collateral Ligament (MCL) injuries. Functional outcomes were assessed at two weeks, three months, and six months postoperatively using the Mayo Elbow Performance Score (MEPS) and Visual Analog Scale (VAS) for pain. The normality of continuous variables was assessed using the Shapiro-Wilk test. Repeated measures analysis of variance (Repeated Measures ANOVA) was used to compare serial postoperative values of MEPS, Visual Analogue Scale (VAS) scores, and Range of Motion (ROM) over different follow-up intervals. In cases where assumptions for parametric testing were not met, the Friedman test was utilised.

Results: The mean age of participants was 26.8±3.3 years, with a male predominance (18 males, 2 females). Injuries were primarily caused by falls (80%) and sports-related trauma (20%). The average time to surgery was 5±1.8 days. At the final follow-up, significant improvements were observed, with mean ROM (flexion-extension) of 135.4°±20.7°, mean rotation of 95°±25.1°, MEPS of 92.4±8.8, and mean VAS score of 0.3±0.5. Outcomes were excellent in 75% of patients, good in 15%, and fair in 10%. No significant complications, such as infections, non-union or heterotopic ossification were reported.

Conclusion: The integration of FibreWire and Endobutton offers a minimally invasive, biomechanically robust approach in managing terrible triad injuries, facilitating early mobilisation and reducing the risk of postoperative stiffness. This technique simplifies surgical complexity by avoiding the need for dual tunnels in the ulna while enhancing joint stability and function.

Keywords: Coronoid process, Elbow dislocation, Internal fixators, Joint instability, Radial head fractures

INTRODUCTION

Terrible triad injury of the elbow is a complex injury pattern classically defined by the combination of posterior elbow dislocation, radial head fracture, and coronoid process fracture [1]. These injuries are frequently associated with disruption of the LCL complex and varying degrees of capsuloligamentous damage, resulting in significant elbow instability and poor functional outcomes if inadequately treated [2,3]. Traumatic injuries to the forearm and elbow account for roughly 15% of upper-limb musculoskeletal injuries presenting to emergency departments each year [4].

The elbow is a highly congruent joint that relies on both static and dynamic stabilisers for normal function. Primary stabilisers include the ulnohumeral articulation, the anterior bundle of the MCL, and the Lateral Ulnar Collateral Ligament (LUCL), while secondary stabilisers include the radiocapitellar articulation, common flexor-extensor musculature, and the joint capsule. The normal ROM for the elbow is typically 0° to 135-140° for flexion and extension, 80-85° for supination, and 80°-85° for pronation [5]. Even minimal disruption of these stabilising structures can significantly impair elbow biomechanics and functional mobility. Functional elbow motion required for activities of daily living generally ranges from 30° to 130° of flexion-extension and 50° each of pronation and supination [6]. Functionally, the anterior bundle of the MCL offers resistance to valgus stress, contributing to static elbow stability, whereas the LUCL is integral in counteracting varus forces and averting posterolateral rotational instability [7]. Therefore, restoration of joint congruity and stability with early mobilisation is essential for achieving satisfactory clinical outcomes.

Over the past two decades, substantial advances have been made in understanding the pathoanatomy and management principles of terrible triad injuries. Current surgical management strategies commonly include radial head fixation or replacement, repair of the LCL complex, fixation of the coronoid fracture, and restoration of capsular stability. Despite these advances, the optimal surgical approach remains controversial. Conventional fixation techniques for coronoid fractures and anterior capsular repair often require technically demanding procedures, multiple bone tunnels, additional surgical exposures, prolonged operative time, and extensive soft-tissue dissection [8]. Furthermore, inadequate fixation or persistent instability may compromise early rehabilitation and lead to poor functional recovery [9].

Previous studies have emphasised the critical role of the coronoid process and anterior capsule in maintaining elbow stability, particularly in preventing recurrent posterior instability and posterolateral rotatory instability. Small coronoid fractures, especially Regan-Morrey type I injuries, are frequently associated with anterior capsular avulsion and may contribute significantly to instability if left untreated [10]. Although various fixation methods such as suture anchors, transosseous sutures, plates, and screws have been described, there remains no universally accepted technique for simultaneous restoration of anterior capsular integrity and elbow stability while minimising surgical complexity.

The use of high-strength suture materials such as FibreWire and cortical suspensory fixation devices such as Endobutton has gained increasing acceptance in orthopaedic ligament reconstruction because of their excellent tensile strength, favourable biomechanical characteristics, and ability to provide stable fixation with limited soft-tissue disruption. In the setting of elbow instability, Pai V and Pai V reported satisfactory outcomes using suture-anchor fixation of the anterior capsule to the coronoid in six terrible triad injuries with Regan–Morrey type I coronoid fractures, highlighting the importance of capsular restoration for elbow stability [11]. More recently, Salwan A et al., described the use of an Endobutton construct for fixation of a small coronoid avulsion fragment in a terrible triad injury, demonstrating the feasibility of suspensory fixation for coronoid-based capsular injuries [12]. Furthermore, the recent review by de Klerk HH et al., emphasised the critical role of the coronoid and anterior capsule in maintaining elbow stability and discussed the evolving fixation strategies for coronoid fractures associated with terrible triad injuries [13]. However, a review of the literature reveals none of studies specifically evaluating anterior capsular augmentation using a single trans-ulnar tunnel with FibreWire and Endobutton fixation in terrible triad injuries of the elbow. Most reported techniques rely on suture anchors, multiple bone tunnels, lasso constructs, or more extensive fixation methods for coronoid and capsular repair, potentially increasing surgical complexity and soft-tissue dissection. Consequently, the clinical utility and reproducibility of a single-ulnar-tunnel FibreWire-Endobutton technique remain inadequately investigated.

Thus, the present study introduces a novel surgical technique utilising FibreWire and Endobutton constructs for anterior capsular augmentation combined with radial head fixation and LCL repair through a single lateral approach. The rationale behind this technique is to provide stable biomechanical fixation while avoiding the need for dual ulnar tunnels, thereby simplifying the procedure, minimising surgical morbidity, and facilitating early postoperative mobilisation. Therefore, the present study aims to evaluate the functional and radiological outcomes of this innovative surgical approach in patients with terrible triad injuries of the elbow.

MATERIALS AND METHODS

This prospective interventional study involved patients treated surgically for terrible triad injuries in Department of Orthopaedics at Government Doon Medical College, Dehradun, Uttarakhand, India from July 2023 to July 2024. The study was conducted after obtaining approval from the Institutional Ethics Committee (IEC) of Government Doon Medical College. Ethical clearance was granted vide Letter No. (IEC/GDMC/2023/81 dated 09/01/2023). Written informed consent was obtained from all participants prior to inclusion in the study.

Inclusion criteria: Patients aged ≥18 years, acute terrible triad injury of the elbow, posterior elbow dislocation with radial head fracture and Regan-Morrey type I coronoid fracture [14], closed injuries were included in the study.

Exclusion criteria: Patients aged <18 years, severely comminuted radial head fractures requiring arthroplasty, open fractures, polytrauma or associated injuries affecting the treatment protocol or functional outcome assessment were excluded from the study.

Sample size: Due to the relatively low incidence of terrible triad injuries of the elbow, a convenience sampling method was adopted. All eligible consecutive patients presenting during the study period and meeting the inclusion criteria were prospectively included. Thus, a total sample size of 20 patients was obtained.

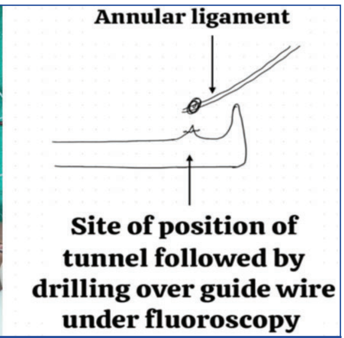
Study Procedure

A total of 20 patients underwent a standardised surgical protocol comprising anterior capsule augmentation for small coronoid fractures, radial head fixation, and LCL repair using a double-loaded suture anchor. Each patient presented with a radial head fracture, posterior elbow dislocation, a Regan-Morrey type I coronoid fracture [14].

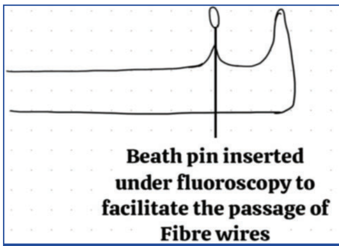
Intraoperative assessment for MCL integrity was performed using the moving valgus stress test [15], which was negative in all cases. Radial head preservation was achieved in all patients, and LCL repair was performed by anchoring to the isometric point on the lateral epicondyle. Postoperative follow-ups were conducted at two weeks, three months, and six months in the outpatient department. The functional outcome was assessed using the MEPS [16]. The MEPS is a validated physician-based scoring system used for evaluating elbow function. It consists of four components: pain (45 points), ROM (20 points), stability (10 points), and functional status/activity of daily living (25 points), with a total maximum score of 100 points. Based on the final score, outcomes are interpreted as excellent (90-100 points), good (75-89 points), fair (60-74 points), and poor (<60 points). Higher scores indicate better elbow function and patient outcome.

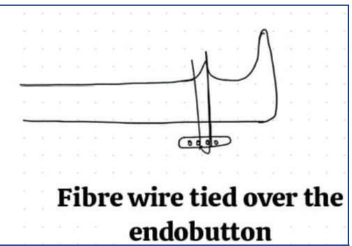
Surgical technique: Following induction of anaesthesia, the patient was placed in the supine position with the arm abducted, elbow flexed, and internally rotated on a hand table. The surgical site was then prepared according to standard aseptic protocols, involving application of antiseptic solution and appropriate sterile draping. The patient was positioned supine with the affected upper limb placed on a hand table and the elbow flexed to 90°, following which a lateral Kocher approach was performed to expose the lateral elbow structures [Table/Fig-1] [17]. The interval between the extensor carpi ulnaris and anconeus muscles was developed to identify the disrupted LCL complex [Table/Fig-2]. Anterior capsular augmentation was performed using a No. 5 FibreWire passed through the anterior capsule and routed through a single trans-ulnar tunnel positioned close to the coronoid base [Table/Fig-3]. Tunnel positioning and drilling were performed under fluoroscopic guidance using a 3.2-mm drill bit over a guidewire [Table/Fig-4]. A Beath pin was subsequently inserted to facilitate shuttle passage of the FibreWire through the ulnar tunnel [Table/Fig-5]. The FibreWire was then secured over an Endobutton on the posterior ulnar cortex, thereby avoiding the need for dual ulnar tunnels [Table/Fig-6]. Following appropriate tensioning, the FibreWire construct was tied securely over the Endobutton while maintaining concentric reduction of the elbow joint [Table/Fig-7]. Attention was then directed toward fixation of the radial head fracture, which was initially stabilised using a Kirschner wire [Table/Fig-8]. Definitive fixation of the radial head fragment was subsequently achieved using a Herbert screw following provisional K-wire stabilisation [Table/Fig-9]. The LCL complex was repaired using a double-loaded suture anchor inserted at the isometric point over the lateral epicondyle [Table/Fig-10]. Preoperative radiographs demonstrated posterior elbow dislocation associated with radial head and coronoid fractures consistent with terrible triad injury of the elbow [Table/Fig-11a,b]. Following successful closed reduction performed in the emergency department, X-ray of the elbow was taken which showed restoration of joint congruity [Table/Fig-12]. Post-reduction, three-dimensional CT reconstruction was also done to evaluate fracture morphology and facilitate surgical planning [Table/Fig-13]. The patients were then taken up for surgery. The immediate intraoperative fluoroscopic assessment following fixation and ligamentous repair was done during which elbow ROM and stability were evaluated under live

[Table/Fig-1]: Elbow placed in 90 degrees flexion, a 6-8 cm incision is made directly over the middle of the lateral epicondyle. A Kocher approach was utilised to provide optimal exposure of the lateral epicondyle of the humerus and the LUCL [17]. (Images from left to right)
[Table/Fig-2]: Torn fibres of the Lateral Collateral Ligament (LCL) are identified. Incision is given between the ECU and Anconeus muscles. Subcutaneous tissue is incised in line with the incision and flaps are raised to expose the fascia over the muscles.



[Table/Fig-3]: With the elbow kept reduced a non-absorbable No. 5 FibreWire strand was passed through the anterior capsule in a superior-to-inferior direction. The FibreWire, designed to engage the anterior capsule, was routed through a tunnel created in the posterior aspect of the ulna, with its entry point strategically positioned as close as possible to the coronoid base on the ulna's anterior surface.
[Table/Fig-4]: The diagram showing the site of position of tunnel followed by drilling with 3.2 mm drill bit over guide wire under fluoroscopy. (Images from left to right)
Source: Authors' own illustration





[Table/Fig-5]: The diagram showing Beath pin inserted under fluoroscopy to facilitate the passage of FibreWire from anterior to bring it out of the bone on the posterior aspect.
Source: Authors' own illustration
[Table/Fig-6]: The diagram showing the FibreWire tied over the Endobutton. (Images from left to right)
Source: Authors' own illustration.
Advantage: This procedure's advantage is that the use of an Endobutton eliminates the need for creating two separate tunnels in the ulna. In contrast, the absence of an Endobutton necessitates the creation of two tunnels to facilitate securing the knot.

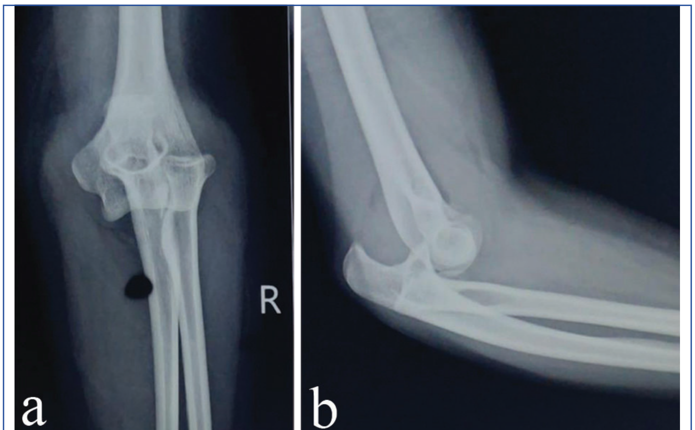
C-arm imaging to confirm satisfactory restoration of joint stability [Table/Fig-14]. The immediate postoperative radiograph obtained on the day of surgery, demonstrated satisfactory reduction of the ulnohumeral and radiocapitellar joints, appropriate positioning of the fixation construct, and restoration of overall elbow alignment [Table/Fig-15].

Postoperative Management

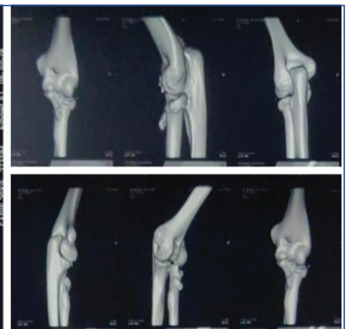
Postoperatively, the operated upper limb was immobilised in a posterior above-elbow splint with the elbow maintained at

[Table/Fig-7]: The tails of the non-absorbable No. 5 FibreWire passed through the anterior capsule, tensioned appropriately, and secured over the posterior aspect of the ulna using an Endobutton at every step ensuring that elbow is kept reduced.
[Table/Fig-8]: Following the augmentation of the anterior capsule, the next step involved addressing the radial head fracture. A Kirschner wire (K-wire) initially stabilised the radial head fragment.

[Table/Fig-9]: Radial head fragment was preliminary fixed with the K-wire before Herbert screw fixation.
[Table/Fig-10]: The "bare spot" on the lateral epicondyle of the humerus serves as the anatomical landmark for the origin of the Lateral Collateral Ligament (LCL). The LCL is anchored to the isometric point on the lateral epicondyle using a 5 mm double-loaded suture anchor. Reconstruction of the LCL and the radial annular ligament is performed following the placement of the suture anchor at this isometric point. (Images from left to right)

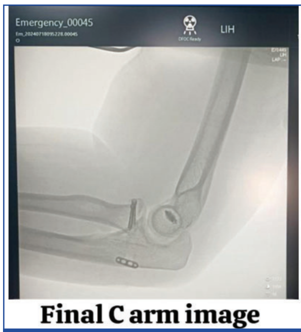


[Table/Fig-11]: a) Pre-op the dislocated elbow with all the terrible triad injuries; b) Pre-op- the dislocated elbow in lateral view.



[Table/Fig-12]: Elbow is reduced in emergency before CT scan.
[Table/Fig-13]: The 3D CT scan of the elbow after reduction. (Images from left to right)

approximately 90° of flexion and the forearm in neutral rotation for initial soft-tissue protection and pain control. The splint was



[Table/Fig-14]: Immediate postoperative image taken under C-Arm - elbow ROM and stability checked under live fluoroscopy.
[Table/Fig-15]: Image showing the immediate postoperative X-ray of the patient on the day of surgery. (Images from left to right)

maintained for approximately 10-14 days until suture removal and subsidence of postoperative swelling. During this period, patients were encouraged to perform active movements of the wrist, hand, and shoulder to prevent stiffness and oedema.

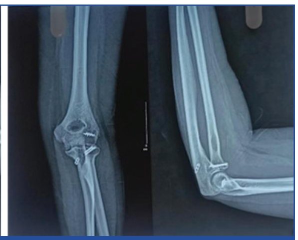
Following splint removal at the first postoperative follow-up, a supervised rehabilitation protocol emphasising early protected mobilisation was initiated. Active-assisted elbow flexion and extension exercises were started as tolerated under physiotherapy supervision, with care taken to avoid varus stress across the elbow joint. Forearm pronation and supination exercises were performed with the elbow flexed at 90° to minimise stress on the repaired LCL complex. Passive stretching and forceful manipulation were avoided during the early postoperative phase.

A hinged elbow brace was utilised in selected patients with residual apprehension or soft-tissue laxity, allowing controlled motion while protecting ligamentous repairs. Gradual progression of the ROM was encouraged over the subsequent six weeks with the goal of achieving a functional arc of motion while maintaining joint stability.

Weight-bearing restrictions were strictly maintained during the early healing period. Patients were advised to avoid lifting weights, pushing activities, rising from a chair using the operated limb, or axial loading through the elbow for a minimum of six weeks postoperatively. Light activities of daily living were permitted as tolerated after 2-3 weeks. Progressive strengthening exercises for the elbow and forearm musculature were initiated after radiological and clinical evidence of stability, typically at 6-8 weeks postoperatively. Return to heavy manual work, contact sports, and strenuous upper-limb activities were generally permitted after 3-4 months depending on functional recovery and radiographic healing.

Indomethacin prophylaxis was administered postoperatively to reduce the risk of heterotopic ossification unless contraindicated. Patients were followed clinically and radiographically at regular intervals to assess fracture healing, elbow stability, ROM, pain, and functional outcome using the MEPS.

Indomethacin was also given to the patients postoperatively [18]. Functional outcomes were assessed using the MEPS, VAS for pain, and ROM measurements at 2 weeks, 3 months, and 6 months postoperatively. Pain intensity was evaluated using the VAS on a scale ranging from 0 to 10, where 0 represented no pain and 10 represented the worst imaginable pain [19]. Elbow ROM assessment included measurement of flexion-extension arc and forearm pronation-supination arc using a standard goniometer during clinical examination. Radiographic evaluation was additionally performed to assess maintenance of reduction, fracture healing, and implant position during follow-up visits. [Table/Fig-16-19] demonstrate the postoperative outcomes at follow-up. [Table/Fig-16,17] show the radiographs at three and six months, respectively, confirming maintained reduction, stable fixation, and satisfactory healing. [Table/Fig-18,19] illustrate near-full elbow extension and full elbow flexion at six months, indicating excellent functional recovery.



[Table/Fig-16]: Postoperative X-ray at three months follow-up.
[Table/Fig-17]: Postoperative X-ray at six months follow-up. (Images from left to right)

[Table/Fig-18]: Near full extension of elbow at six months follow-up.
[Table/Fig-19]: Full flexion of elbow at six months follow-up.

STATISTICAL ANALYSIS

All statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) software version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean±Standard Deviation (SD), while categorical variables were presented as frequencies and percentages. Descriptive statistics were used to summarise demographic data, injury characteristics, operative details, and postoperative outcomes. The normality of continuous variables was assessed using the Shapiro-Wilk test. Repeated measures analysis of variance (Repeated Measures ANOVA) was used to compare serial postoperative values of MEPS, VAS scores, and ROM over different follow-up intervals. In cases where assumptions for parametric testing were not met, the Friedman test was utilised. A p-value <0.05 was considered as statistically significant.

RESULTS

Twenty patients (18 males and 2 female) with a mean age of 26.8±3.3 years (range, 20 to 33 years) were treated with the current technique. Sixteen fractures were of the right elbow and four were of the left elbow. The causes of injury were fall (16 cases) and sports injury (4 cases). The mean time between the injury and surgery was 5±1.8 days. The mean follow-up period was 8.6±0.7 months (range, 8 to 10 months). At the final follow-up, the average ROM of flexion and extension was 135.4°±20.7°, ROM of rotation was 95°±25.1°, MEPS was 92.4±8.8 (75% were excellent), and VAS was VAS was 0.3±0.5. Fifteen patients had an excellent result, three patients had good results, and two patients had a fair result. No patient reported pain at the final follow-up [Table/Fig-20].

[Table/Fig-21] demonstrates a progressive improvement in elbow function over time, as reflected by the distribution of MEPS. The proportion of patients with excellent outcomes increased from 15% at two weeks to 35% at three months and 75% at six months, while the percentage of fair outcomes decreased from 60% to 10% during the same period. Notably, no patient had a poor outcome at any follow-up interval, indicating sustained functional recovery following surgical treatment.

There was significant improvement in all clinical outcome measures over the follow-up period. The mean flexion-extension arc, forearm rotation, and MEPS scores progressively increased from two weeks to six months, while VAS pain scores showed a corresponding decline, indicating improved elbow function and pain relief. Statistical analysis confirmed that these changes were highly significant over time (p-value<0.001), reflecting the effectiveness of the surgical technique in restoring elbow stability and function [Table/Fig-22,23].

Parameter	Details
Total patients	20
Gender	18 males, 2 females
Mean age	26.8±3.3 years (range: 20-33 years)
Side of fracture	Right elbow: 16 cases Left elbow: 4 cases
Causes of injury	Fall: 16 cases Sports injury: 04
Mean time to surgery	5 ±1.8 days
Mean follow-up period	8.6±0.7 months (range: 8-10 months)
ROM (Flexion and Extension)	135.4°±20.7°
ROM (Rotation)	95°±25.1°
MEPS (Mayo Elbow Performance) at 6 months	92.4±8.8
VAS (Pain)	0.3±0.5 Range: 0-2
Outcome results	Excellent: 15 patients Good: 3 patients Fair: 2 patient
Pain at final follow-up	None reported
Complications	None

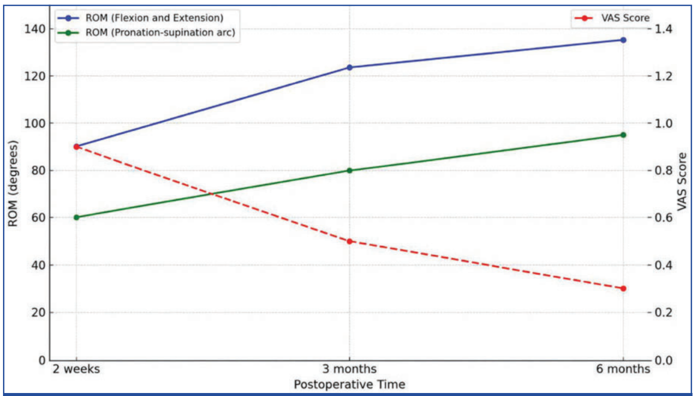
[Table/Fig-20]: Demographic data, surgical outcomes, and follow-up findings.

Outcome	MEPS at 2 weeks N(%)	MEPS at 3 months N(%)	MEPS at 6 months N(%)
Excellent	3 (15%)	7 (35%)	15 (75%)
Good	5 (25%)	10 (50%)	3 (15%)
Fair	12 (60%)	3 (15%)	2 (10%)
Poor	0	0	0
Total	20 (100%)	20 (100%)	20 (100%)

[Table/Fig-21]: Distribution of samples as per the Mayo Elbow Performance Score (MEPS) at different timepoints.

Parameter	2 weeks	3 months	6 months	Statistical test	p-value
ROM (Flexion-Extension)	90.2±13.2°	123.8±17.1°	135.4±20.7°	Repeated Measures ANOVA	<0.001
ROM (Pronation-Supination arc)	60±13.7°	80±18.9°	95±25.1°	Repeated Measures ANOVA	<0.001
VAS score	0.9±0.3	0.5±0.9	0.3±0.5	Friedman Test	<0.001
MEPS	69.4±9.8	83.7±8.9	92.4±8.8	Repeated Measures ANOVA	<0.001

[Table/Fig-22]: Summary of postoperative outcomes.
ROM: Range of motion; VAS: Visual analog scale; MEPS: Mayo elbow performance score. Data are expressed as mean±SD. Repeated-measures ANOVA was used to compare ROM and MEPS values across time points, while the Friedman test was used for VAS scores. Statistical significance was set at $p < 0.05$.



[Table/Fig-23]: Summary of postoperative outcomes (graph).

DISCUSSION

Small coronoid fractures are clinically significant because even minor fragments may retain attachment of the anterior articular capsule. Failure to adequately address these injuries can compromise postoperative stability and functional outcomes. In the setting of extensive ligamentous disruption, conservative management with reduction and immobilisation alone is frequently insufficient to maintain elbow congruity, thereby necessitating surgical stabilisation to prevent chronic instability and recurrent dislocation [20,21]. Fractures involving the tip of the coronoid process (Regan-Morrey type I) are particularly important because the insertion of the anterior capsule lies within this region, approximately 2.5 mm distal to the coronoid tip. These fractures are commonly associated with avulsion of the anterior capsule and contribute substantially to elbow instability if left untreated [22]. Persistent instability following untreated coronoid injuries remains difficult to manage and may predispose to recurrent dislocation, stiffness, and post-traumatic arthritis [23,24]. Furthermore, insufficiency of the coronoid process may result in posterolateral rotatory instability of the elbow [25].

The integrity of the anterior capsule plays a crucial role in elbow stability, particularly against posterior translation and rotational instability. Previous biomechanical and clinical studies have suggested that restoration of anterior capsular integrity may be equally or even more important than isolated radial head fixation or collateral ligament reconstruction in certain terrible triad injuries [26,27]. Accordingly, the present technique focuses on anterior capsular augmentation in addition to radial head fixation and LCL repair, thereby restoring both osseous and soft-tissue stabilisers of the elbow.

The functional outcomes observed in the present study compare favourably with previously published literature on terrible triad injuries. Egol KA et al., reported satisfactory functional outcomes following treatment of elbow fracture-dislocations using a standardised surgical protocol [28]. Chen HW et al., reported relatively high complication rates, residual stiffness, and recurrent instability following conventional fixation techniques and demonstrated improved outcomes with systematic repair of all stabilising structures but noted persistent postoperative stiffness in a substantial proportion of patients [29]. In the current study, the mean MEPS at final follow-up was 92.4±8.8, with 75% excellent outcomes and no recurrent instability or non-union, suggesting that the described construct provides satisfactory stability while permitting early mobilisation. Similarly, the average flexion-extension arc of 135.4° compares favourably with outcomes reported in prior studies utilising transosseous sutures, suture anchors, or plating constructs for coronoid fixation [23,24].

Compared with traditional trans-ulnar drilling techniques, the present method offers several technical and biomechanical advantages. Conventional transosseous suture fixation often requires the creation of two separate ulnar tunnels for knot tying and fixation, which may increase operative complexity, prolong surgical time, and potentially weaken the proximal ulna. The use of the Endobutton construct in the present technique eliminates the need for dual tunnels, allowing secure fixation through a single tunnel while minimising bone loss and soft-tissue dissection. This simplified construct also reduces the requirement for a separate medial approach, thereby decreasing surgical morbidity and risk to neurovascular structures [30].

The biomechanical stability of the Endobutton construct has been well demonstrated in ligament reconstruction surgery, particularly in anterior cruciate ligament and acromioclavicular joint reconstruction procedures. Endobutton fixation provides cortical suspensory fixation with excellent resistance to cyclic loading and high tensile strength, thereby maintaining stable fixation during early rehabilitation. The broad cortical contact area of the Endobutton helps distribute forces across the posterior ulnar cortex and reduces the risk of suture cut-through or fixation failure. Additionally, FibreWire sutures possess superior tensile strength, improved knot security, and greater resistance to elongation compared with conventional braided polyester or absorbable sutures. These biomechanical properties facilitate early controlled mobilisation while maintaining construct integrity [31].

Compared with other suture materials such as Ethibond or absorbable polyglactin sutures, FibreWire demonstrates greater resistance to cyclic fatigue and higher ultimate load to failure. This enhanced mechanical profile may reduce the risk of loosening during rehabilitation and improve maintenance of reduction in unstable elbow injuries. Moreover, better resistance of suture material minimises stress along the suture line and facilitates superior anteroposterior stability [11]. However, FibreWire is associated with certain disadvantages, including increased stiffness of the material, potential difficulty in knot handling, and the possibility of soft-tissue irritation due to its non-absorbable high-strength composition. In addition, improper tensioning may lead to overtightening of the anterior capsule and restriction of elbow motion [32]. Despite these limitations, no suture-related complications were encountered in the present series.

An additional consideration with this technique is the learning curve associated with precise tunnel placement and controlled tensioning of the FibreWire-Endobutton construct. Accurate positioning of the ulnar tunnel close to the coronoid base under fluoroscopic guidance is essential to achieve optimal capsular reduction and avoid malreduction or iatrogenic fracture propagation. Familiarity with fluoroscopic anatomy, suture shuttle techniques, and maintenance of elbow reduction during fixation is therefore necessary. Nevertheless, once mastered, the procedure is technically reproducible and may be less invasive than techniques requiring dual tunnels, plates, or separate medial exposures.

One patient in the present study had an associated Distal Radioulnar Joint (DRUJ) injury. Although uncommon in terrible triad injuries, DRUJ involvement may occur as part of complex forearm rotational trauma mechanisms. The patient was managed conservatively after stabilisation of the elbow injury, and no residual DRUJ instability was noted at final follow-up. This finding highlights the importance of careful clinical and radiological assessment of the entire forearm and wrist in patients presenting with complex elbow fracture-dislocations. Thus, the favourable functional outcomes, absence of recurrent instability, and minimal complication profile suggest that this novel FibreWire and Endobutton technique represents a promising alternative for the management of terrible triad injuries of the elbow. The key take-home message from this study is that a single-tunnel FibreWire-Endobutton construct offers a simple, minimally invasive, and effective alternative for restoring elbow stability in terrible triad injuries while promoting early rehabilitation and improved functional recovery.

Limitation(s)

The present study had several limitations that should be acknowledged. First, the relatively small sample size limits the generalisability of the findings and reduces the statistical power of the study. Second, the follow-up duration was relatively short, which may not adequately capture long-term functional outcomes, late instability, post-traumatic arthritis, or delayed complications such as heterotopic ossification. Third, patients with concomitant MCL injuries were excluded; therefore, the effectiveness of this technique in more complex patterns of elbow instability could not be assessed. Finally, severely comminuted radial head fractures requiring arthroplasty were excluded from the study, limiting the applicability of the described technique to cases where radial head preservation and fixation is required.

CONCLUSION(S)

The present study demonstrated that the novel FibreWire and Endobutton technique provides a reliable and biomechanically stable method for managing terrible triad injuries of the elbow. The procedure allowed effective restoration of elbow stability through anterior capsular augmentation, radial head fixation, and LCL repair using a single lateral approach. Favourable functional outcomes were achieved, with significant improvement in ROM, low postoperative pain scores, and a high proportion of excellent MEPS results at final follow-up. The use of the Endobutton construct eliminated the need for dual ulnar tunnels, thereby simplifying the surgical procedure, minimising soft-tissue dissection, and facilitating early postoperative mobilisation. In addition, the technique demonstrated a low complication profile with no cases of recurrent instability, infection, or non-union.

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